First Implementation of the Luminosity Monitor

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EIC Task Force Meeting

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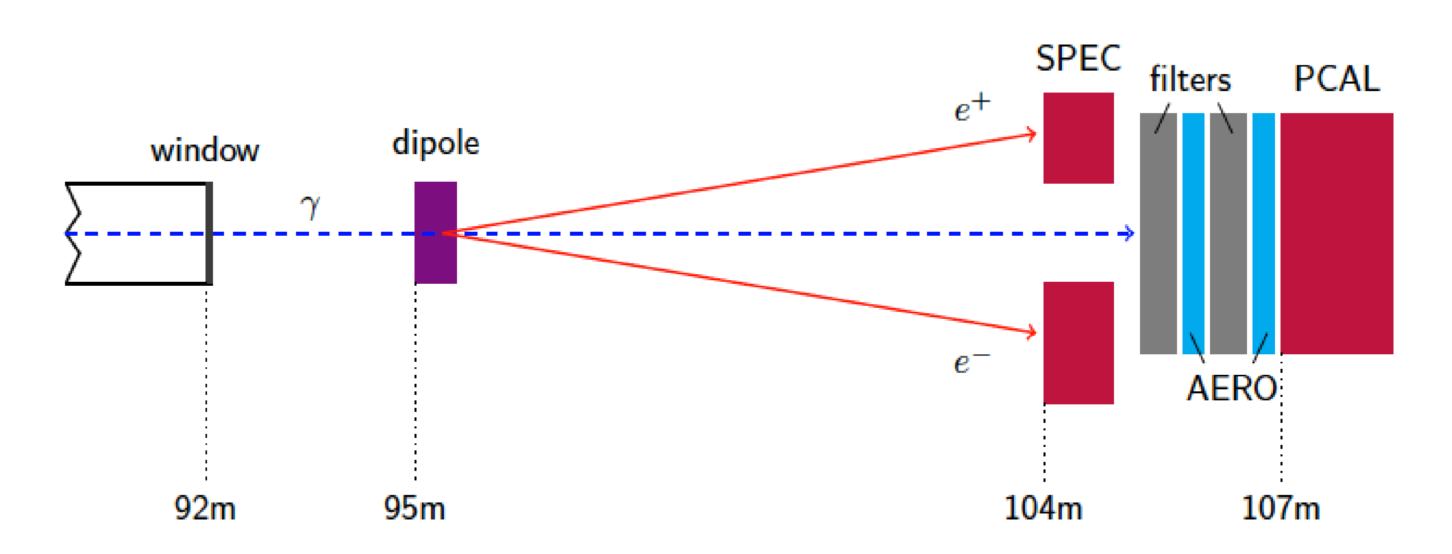
Overview

- Beam luminosity is an essential quantity to know!
- Show the first implementation of the luminosity monitor in the IR in the EicRoot simulation
- follow the HERA II concept (almost exactly)
  - includes pair spectrometer and photon calo
- basic idea of luminosity measurement
  - measure bremsstrahlung photons from ep -> epγ
    - high rate
    - pure QED with precisely calculable cross section
    - luminosity related to the measured rate of photons
    - many effects need to be taken into account for robust measurement (not discussed here)

$$L = \frac{N_\gamma}{A\sigma}$$

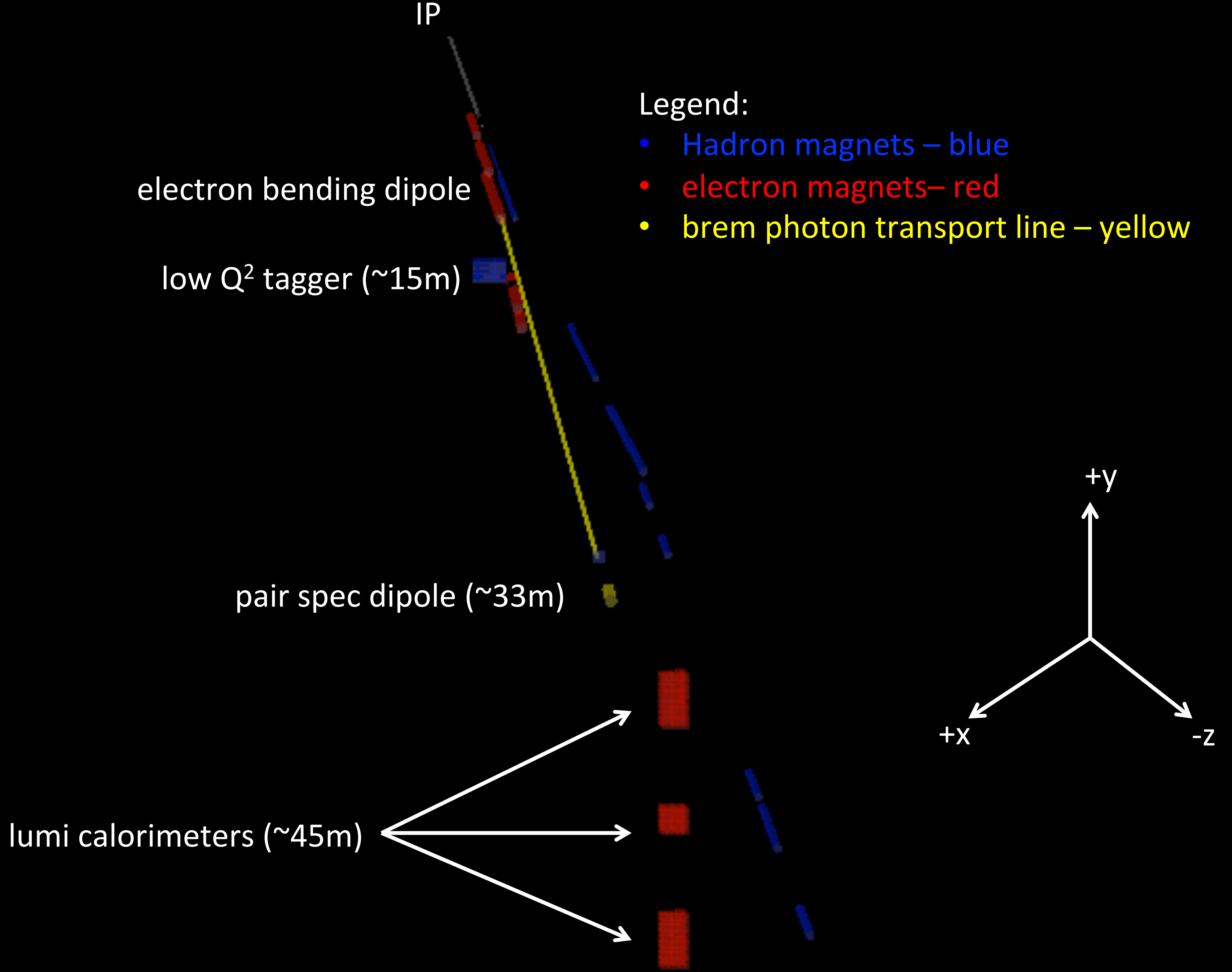
The HERA II setup



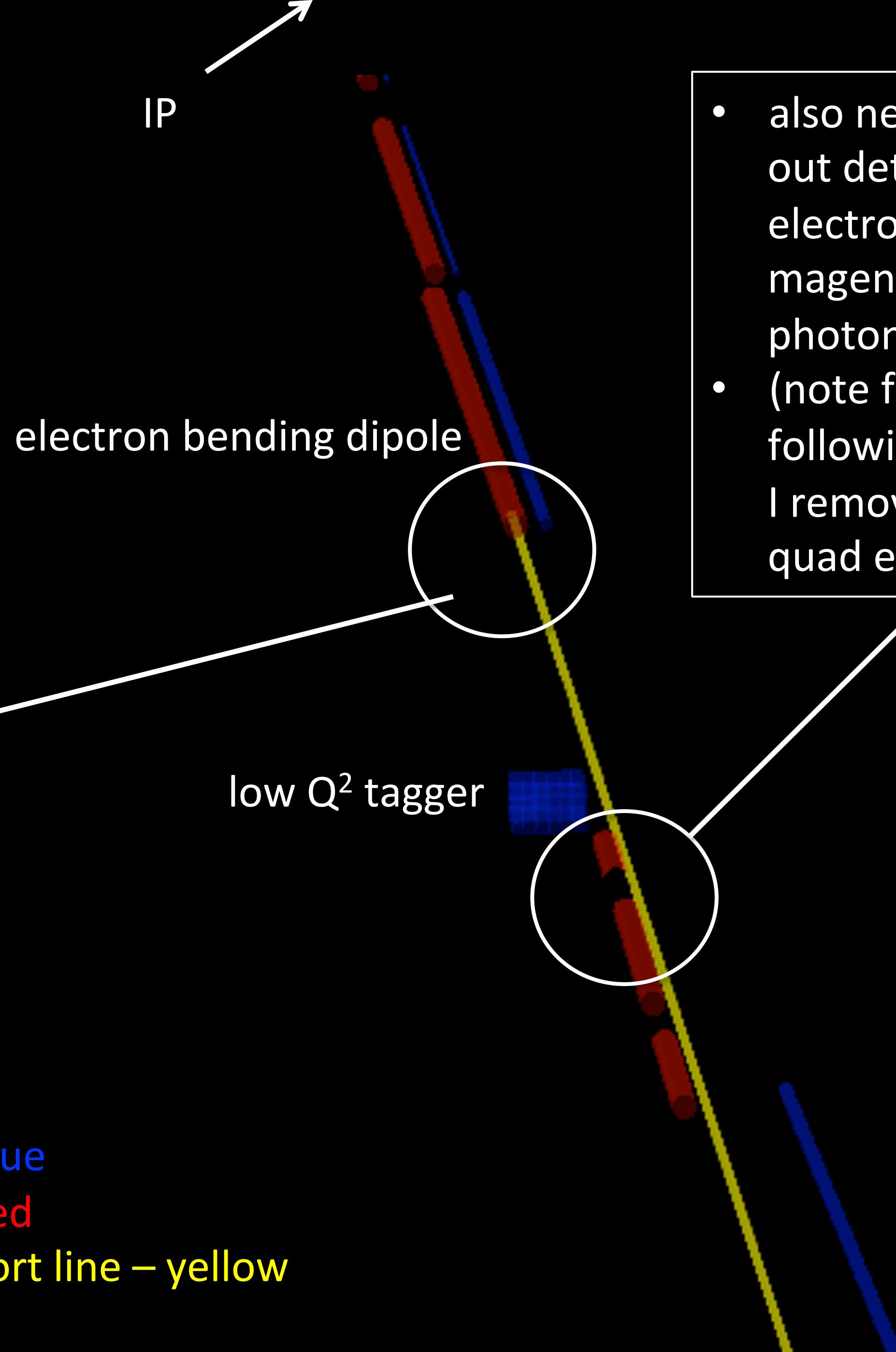
arXiv:1306.1391v2

- collide 27.5 GeV electrons on 920 GeV protons
- overall systematic on luminosity of 1.7%
- photon calorimeter
  - Pbsc sandwich calo of $24X_0$ (20x20 cm^2 per tower)
  - absorbers for synchrotron radiation
  - resolution of 14%/√E (90%/√E) wo (w) absorber plates
- pair spectrometer
  - dipole magnet 60cm long with B=0.5T
  - very similar calo to the photon calo system
  - resolution of 17%/√E

The eRHIC setup

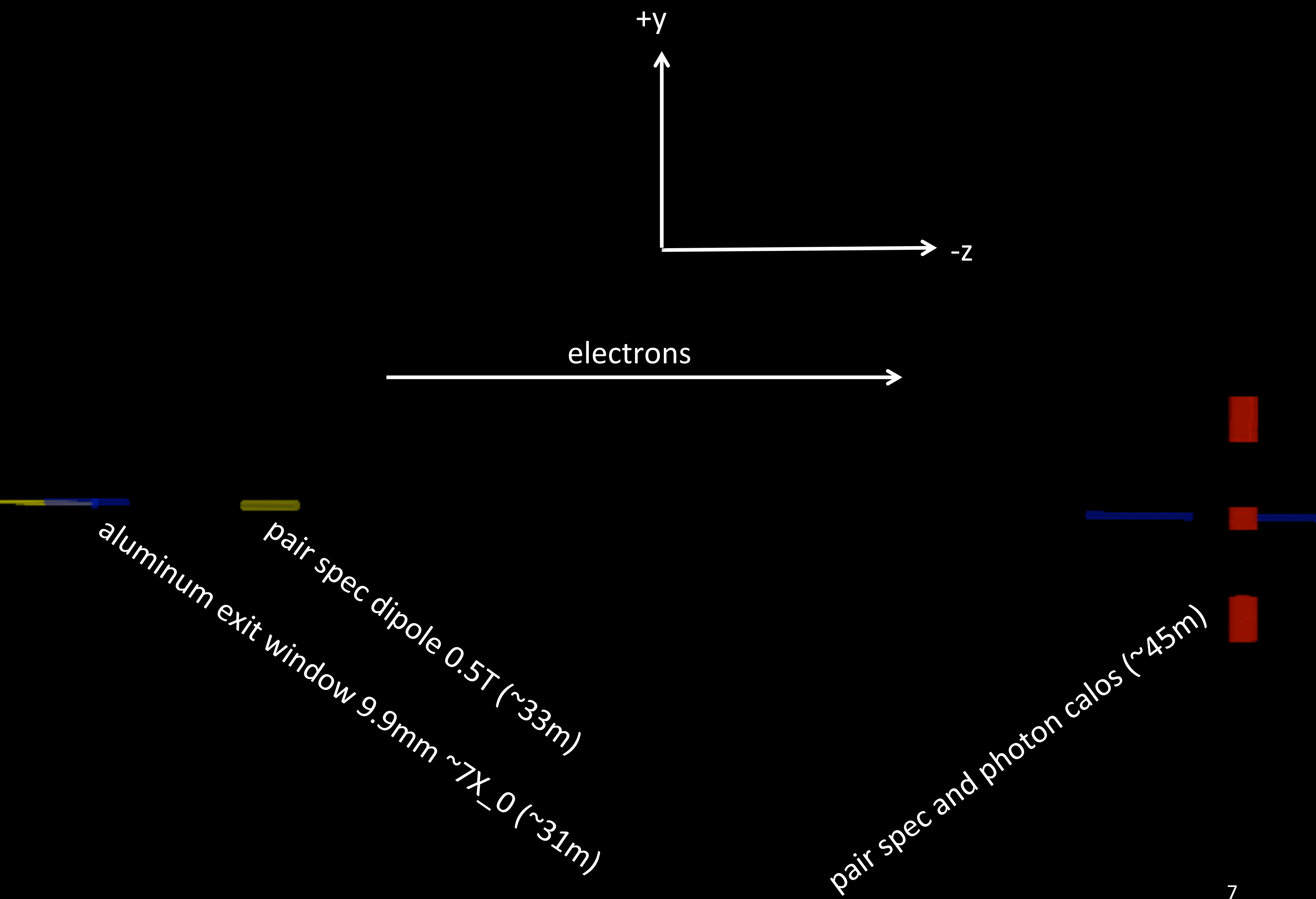

IP
Legend:
Hadron magnets – blue
electron magnets– red
brem photon transport line – yellow
electron bending dipole
low Q^2 tagger (~15m)
pair spec dipole (~33m)
lumi calorimeters (~45m)
+y
+x
-z

- still need to work out the details of how the photon transport line connects with rest of beam line
- (note this simulation uses the v2.1 sim setup, not my modified setup with rotated magnets)



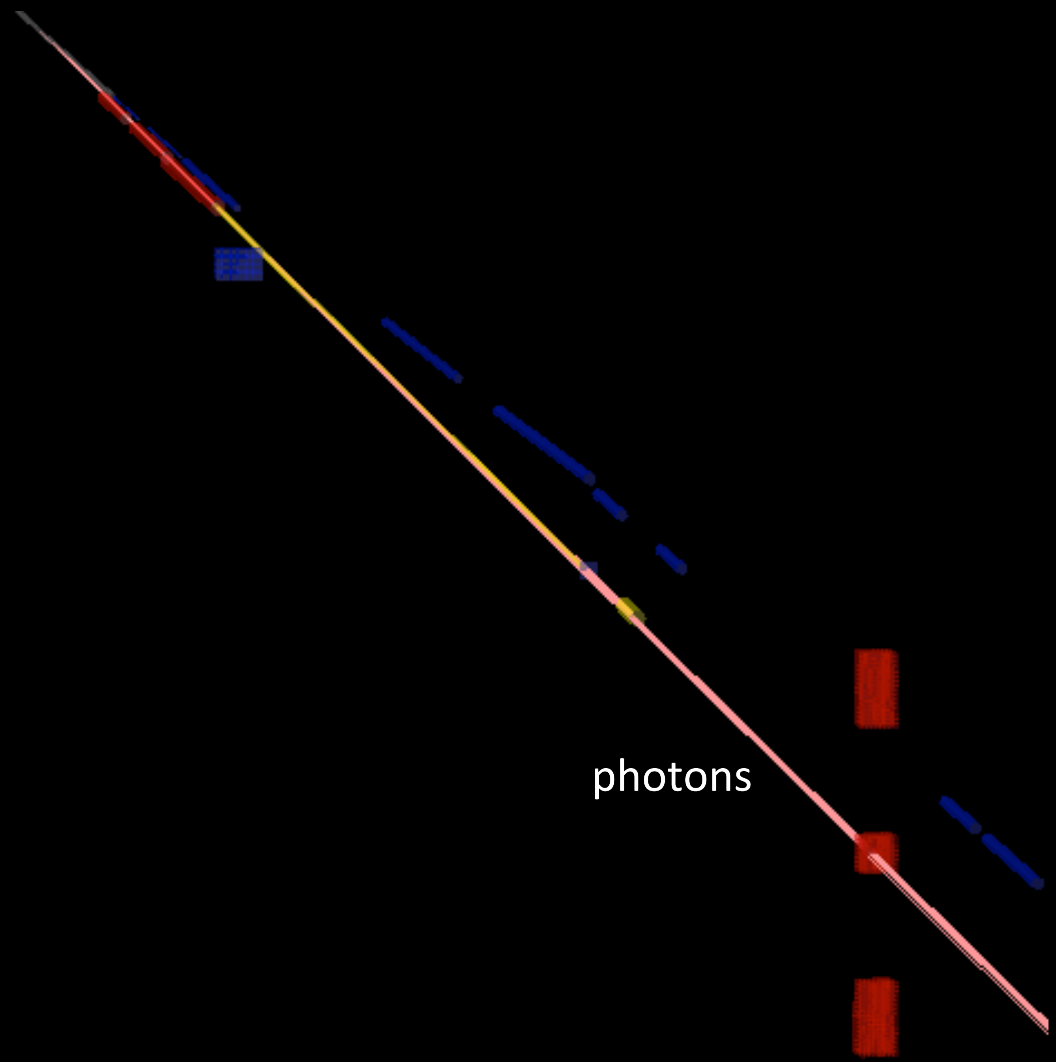
- also need to work out details of other electron quad magents with photon line
- (note for the following simulation I remove those quad elements)

Legend:
- Hadron magnets – blue
- electron magnets– red
- brem photon transport line – yellow

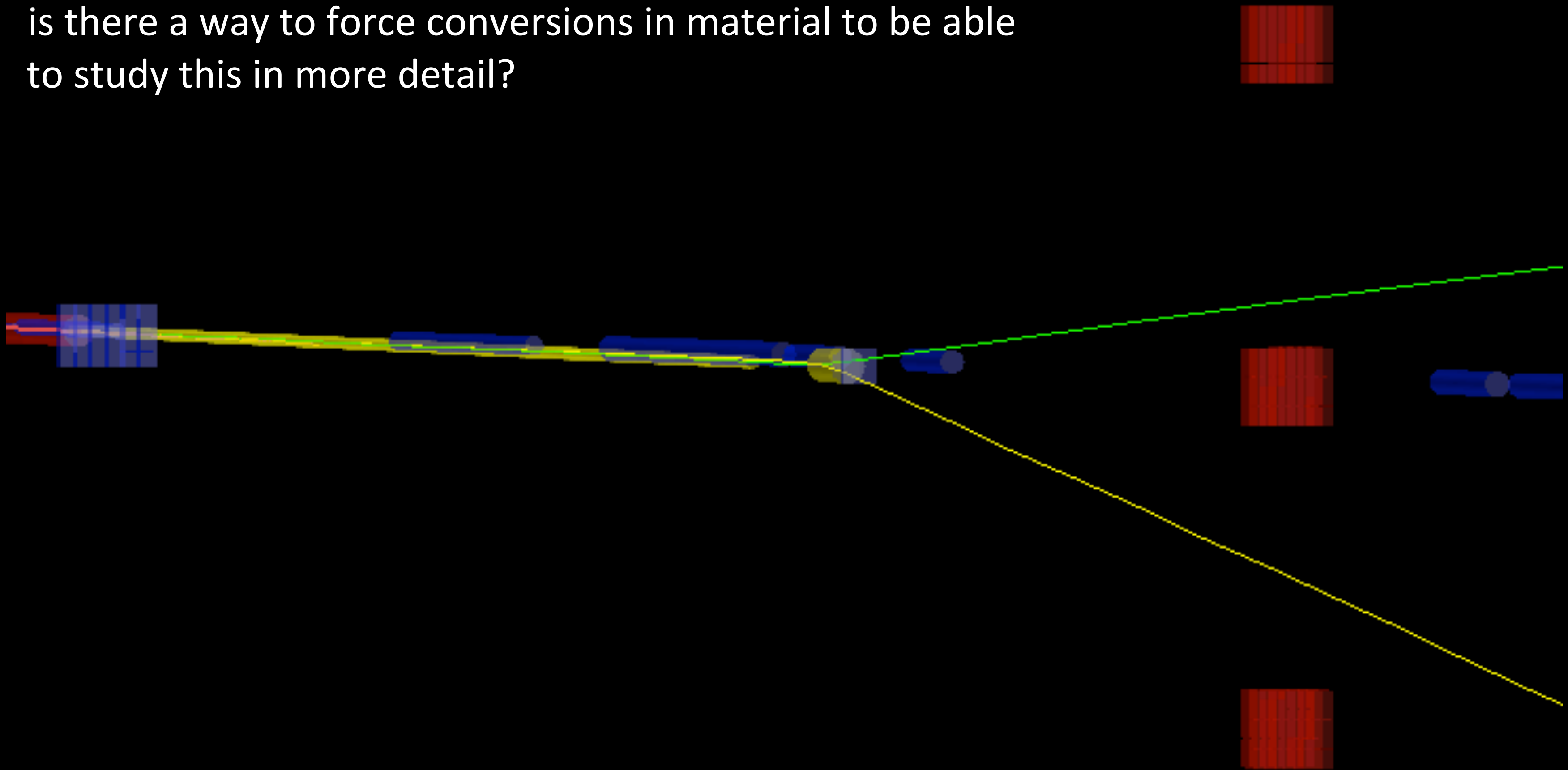

+y
-z
electrons
aluminum exit window 9.9mm ~7X_0 (~31m)
pair spec dipole 0.5T (~33m)
pair spec and photon calos (~45m)

Photons in the transport line

- throw 100 photons theta<2mrad (relative to the electron beam), phi = 0

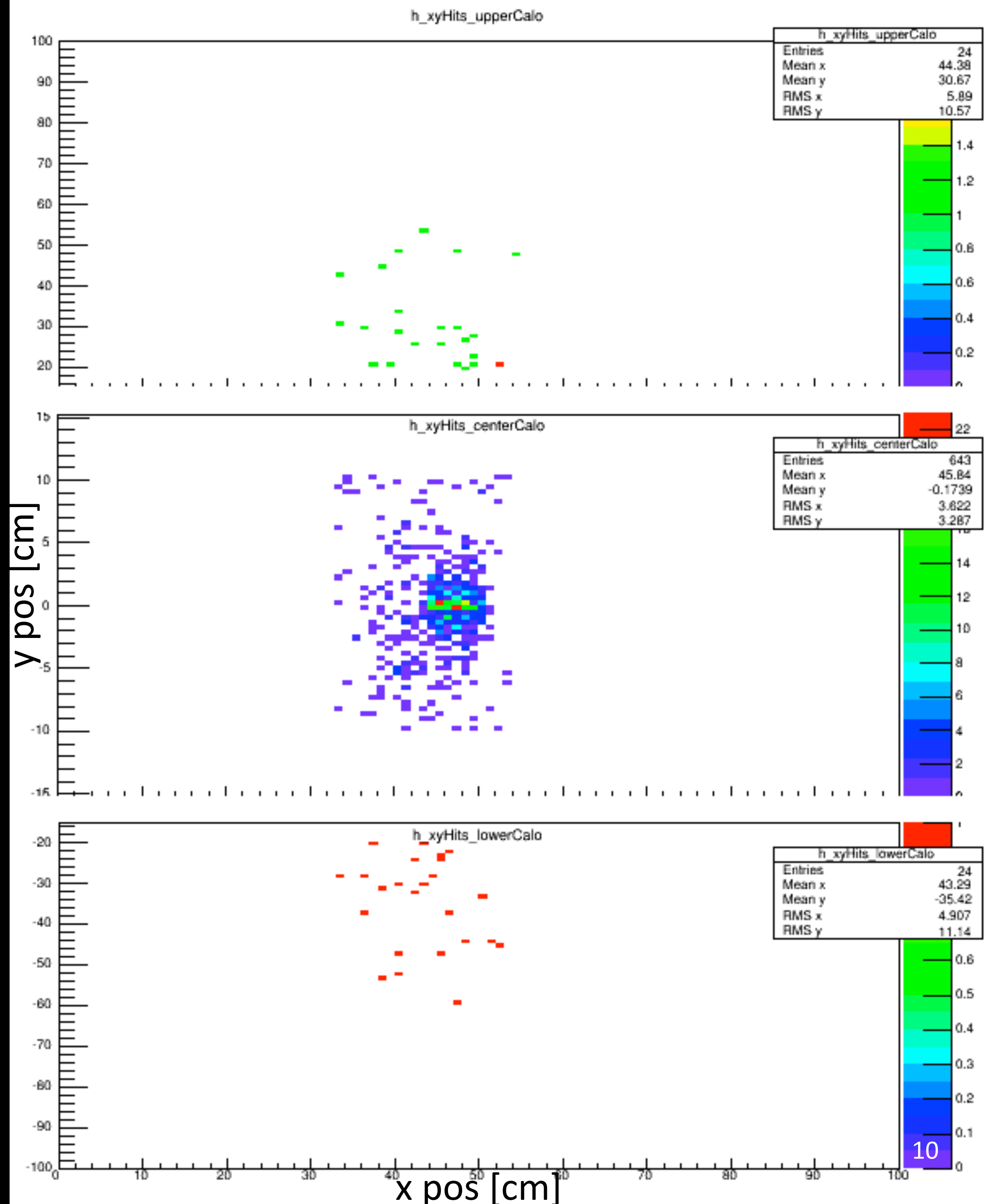


- cannot find a screen shot of a conversion in the Aluminum exit window of the photon line
- but this is pretty close
- at least shows there is a dipole field
- maybe need to adjust the calos
- is there a way to force conversions in material to be able to study this in more detail?



More Quantitative Acceptance

- not sure how to access information about secondary tracks
- to get around this, divide events into two samples
  - conversion events: events with both upper and lower calos having > 20 hits
  - photon events: events with center calo > 20 hits
- ratio of conversion event to photon event ~3.7% (converter prob ~9%)



Next Steps

- Evaluate the phase space of bremsstrahlung photons
  - currently debugging DJANGO generator for this purpose
    - code as it is crashes
  - this information will be used to fine tune the placement of the IR elements
    - typical scattering angle of photons to contrain radius of photon transport line
    - typical energy of photons to determine dipole field in the spectrometer
  - at HERA, the spread of photons due to the energy/transverse spread of the beam much larger than the typical scattering angle of brem. photons
    - need to evaluate this as well
    - already have the expected beam emittance, beta function, etc at IP
- relay our geometrical needs to CAD for further optimization
  - get some drawings, look where we can fit the calos, etc.